CLAIMS

What is claimed is:

1. A method for singulating at least one semiconductor die from a semiconductor wafer, the method comprising:

providing a semiconductor wafer having a body including an active surface and an opposing, bottom surface;

forming at least one trench in the semiconductor wafer body from the bottom surface thereof in alignment with a plurality of streets on the active surface circumscribing a location of at least one semiconductor die; and

cutting through the semiconductor wafer body with at least one laser beam along the plurality of streets between the active surface of the semiconductor wafer body and the at least one trench.

2. The method of claim 1, where forming at least one trench in the semiconductor wafer body comprises etching the at least one trench.

3. The method of claim 2, wherein etching the at least one trench comprises performing a wet etch or a dry etch.

4. The method of claim 2, wherein etching the at least one trench comprises performing an anisotropic etch or an isotropic etch.

5. The method of claim 2, further comprising reducing a thickness of the semiconductor wafer body prior to etching the at least one trench.

6. The method of claim 5, wherein reducing a thickness of the semiconductor wafer body comprises at least one of backgrinding and performing an etch back of the semiconductor wafer body.

7. The method of claim 2, wherein etching the at least one trench in the semiconductor wafer body comprises etching the at least one trench to a depth of about 60% to about 90% of a thickness of the semiconductor wafer body.

8. The method of claim 1, further comprising forming the at least one trench to a width greater than a beam width of the at least one laser beam.

9. The method of claim 1, wherein forming at least one trench in the semiconductor wafer body comprises cutting the at least one trench with at least another laser beam.

10. The method of claim 9, further comprising reducing a thickness of the semiconductor wafer body prior to cutting the at least one trench.

11. The method of claim 10, wherein reducing a thickness of the semiconductor wafer body comprises at least one of backgrinding and performing an etch back of the semiconductor wafer body.

12. The method of claim 9, wherein cutting the at least one trench in the semiconductor wafer body comprises cutting the at least one trench to a depth of about 60% to about 90% of a thickness of the semiconductor wafer body.

13. The method of claim 9, further comprising traversing the at least another laser beam to impinge the semiconductor wafer body along a path and substantially concurrently traversing the at least one laser beam to impinge the semiconductor wafer body along the same path subsequent to impingement of the at least another laser beam.

14. The method of claim 9, wherein cutting the at least one trench in the semiconductor wafer body with at least another laser beam comprises substantially concurrently cutting a plurality of laterally adjacent trenches in the semiconductor wafer body with a plurality of laser beams in a single pass across the semiconductor wafer.

15. The method of claim 14, wherein cutting a plurality of laterally adjacent trenches in the semiconductor wafer body with a plurality of laser beams comprises cutting a plurality of substantially parallel trenches using a plurality of lasers disposed in a row perpendicular to a direction of mutual travel between the plurality of lasers and the semiconductor wafer.

16. The method of claim 15, further comprising cutting a second plurality of substantially parallel trenches using the plurality of lasers after rotationally reorienting either the semiconductor wafer or the row of lasers perpendicular to the direction of mutual travel.

17. The method of claim 1, wherein cutting through the semiconductor wafer body with at least one laser beam along the plurality of streets between the active surface of the semiconductor wafer body and the at least one trench comprises cutting from the active surface of the semiconductor wafer body.

18. The method of claim 1, wherein cutting through the semiconductor wafer body with at least one laser beam along the plurality of streets between the active surface of the semiconductor wafer body and the at least one trench comprises cutting from the bottom surface of the semiconductor wafer body along the at least one trench.

19. The method of claim 1, wherein cutting through the semiconductor wafer body with at least one laser beam along the plurality of streets between the active surface of the semiconductor wafer body and the at least one trench comprises cutting a path having a width of less than 80 μm.

20. The method of claim 19, wherein cutting a path having a width of less than 80 μm comprises cutting a path having a width of about 1 μm.

21. The method of claim 1, wherein cutting through the semiconductor wafer body with at least one laser beam along the plurality of streets between the active surface of the semiconductor wafer and the at least one trench comprises cutting along at least some of the plurality of streets with a plurality of laser beams in a single pass across the semiconductor wafer.

22. The method of claim 21, wherein cutting along at least some of the plurality of streets with a plurality of laser beams in a single pass across the semiconductor wafer comprises cutting with a plurality of lasers disposed in a row perpendicular to a direction of mutual travel between the plurality of lasers and the semiconductor wafer.

23. The method of claim 22, further comprising cutting along at least some other of the plurality of streets using the plurality of lasers after rotationally reorienting either the semiconductor wafer or the row of lasers perpendicular to the direction of mutual travel.

24. The method of claim 1, wherein forming the at least one trench comprises forming a plurality of trenches respectively circumscribing locations of a plurality of semiconductor dice.

25. A method for singulating at least one semiconductor die from a semiconductor wafer, the method comprising:

providing a semiconductor wafer having a body including an active surface and an opposing, bottom surface;

forming at least one channel in the semiconductor wafer body from the active surface thereof in alignment with a plurality of streets on the active surface circumscribing a location of at least one semiconductor die;

depositing a protective layer of material over at least a portion of the active surface of the semiconductor wafer body and substantially filling the at least one channel with the material; and

cutting through the semiconductor wafer body with at least one laser beam having a beam width narrower than a width of the at least one channel substantially along a center of the at least one channel and through the material therein between the active surface of the semiconductor wafer body and the bottom surface thereof to leave portions of the material covering sidewalls of the at least one channel after cutting through the semiconductor wafer body is complete.

26. The method of claim 25, wherein forming at least one channel in the semiconductor wafer body comprises etching the at least one channel.

27. The method of claim 26, wherein etching the at least one channel comprises performing a wet etch or a dry etch.

28. The method of claim 26, wherein etching the at least one channel comprises performing an anisotropic etch or an isotropic etch.

29. The method of claim 25, wherein forming at least one channel in the semiconductor wafer body comprises cutting the at least one channel using at least one laser beam.

30. The method of claim 25, wherein depositing a protective layer of material comprises depositing a dielectric material.

31. The method of claim 30, wherein depositing a dielectric material comprises depositing a polyimide material.

32. The method of claim 25, wherein depositing a protective layer of material comprises stenciling, screen printing, spraying or spin coating.

33. The method of claim 30, wherein depositing a protective layer over at least a portion of the active surface comprises leaving at least one contact location on the active surface exposed through the protective layer.

34. The method of claim 33, wherein leaving at least one contact location exposed through the protective layer comprises providing at least one opening in the protective layer over the at least one contact location.

35. The method of claim 34, wherein providing the at least one opening comprises selectively depositing the protective layer around the at least one contact location.

36. The method of claim 34, wherein providing at least one opening in the protective layer comprises forming the at least one opening through the protective layer after deposition thereof.

37. The method of claim 34, further comprising forming an under bump metallization (UBM) structure by depositing at least one layer of conductive material in contact with the at least one contact location through the at least one opening.

38. The method of claim 37, further comprising disposing a discrete conductive element on the UBM structure.

39. The method of claim 38, wherein disposing the discrete conductive element on the UBM structure comprises forming or disposing a solder ball on the UBM structure.

40. The method of claim 33, further comprising forming a discrete conductive element on the at least one contact location.

41. The method of claim 40, wherein forming a discrete conductive element comprises forming a discrete conductive element of conductive or conductor-filled epoxy.

42. The method of claim 33, wherein cutting through the semiconductor wafer body with at least one laser beam having a beam width narrower than a width of the at least one channel is effected from the active surface of the semiconductor wafer body.

43. The method of claim 33, wherein cutting through the semiconductor wafer body with at least one laser beam having a beam width narrower than a width of the at least one channel is effected from the bottom surface of the semiconductor wafer body.

44. An apparatus for singulating semiconductor dice from a wafer, comprising:
a wafer holder; and
a first plurality of lasers mounted in a row oriented perpendicular to a first mutual direction of travel between the wafer holder and the first plurality of lasers.

45. The apparatus of claim 44, wherein the wafer holder is mounted for rotation of at least 90° about a vertical axis.

46. The apparatus of claim 44, wherein the first plurality of lasers is mounted for rotation of at least 90° about a vertical axis extending through a location of a center of a wafer to be held by the wafer holder.

47. The apparatus of claim 44, further comprising a second plurality of lasers mounted in a row oriented perpendicular to a second mutual direction of travel between the wafer holder and the second plurality of lasers, wherein the first and second mutual directions of travel are mutually perpendicular.

48. A method of singulating semiconductor dice from a semiconductor wafer, the method comprising:

providing a semiconductor wafer having a body including an active surface and an opposing, bottom surface;

defining a pattern grid circumscribing locations of semiconductor dice on the semiconductor wafer body;

forming a plurality of trenches having a first width partially through the semiconductor wafer body in substantial alignment with the pattern grid; and

forming a plurality of cuts having a second width less than the first width through the semiconductor wafer body in substantial alignment with the plurality of trenches.

49. The method of claim 48, wherein forming the plurality of trenches is effected by etching or by using at least one laser beam.

50. The method of claim 49, wherein forming the plurality of trenches is effected from the bottom surface of the semiconductor wafer body.

51. The method of claim 48, wherein the plurality of cuts is formed using at least one laser beam.

52. The method of claim 51, wherein forming the plurality of cuts is effected from the active surface of the semiconductor wafer body.

53. The method of claim 51, wherein forming the plurality of cuts is effected from the bottom surface of the semiconductor wafer body.

54. A method of singulating semiconductor dice from a semiconductor wafer, the method comprising:

providing a semiconductor wafer having a body including an active surface and an opposing, bottom surface;

defining a pattern grid circumscribing locations of semiconductor dice on the semiconductor wafer body;

forming a plurality of channels having a first width partially through the semiconductor wafer body in substantial alignment with the pattern grid from the active surface of the semiconductor wafer;

substantially filling the plurality of channels with a protective material; and

forming a plurality of cuts having a second width less than the first width substantially through centers of the channels of the plurality and through the semiconductor wafer body.

55. The method of claim 54, wherein forming the plurality of channels is effected by etching or by using at least one laser beam.

56. The method of claim 54, wherein the plurality of cuts is formed using at least one laser beam.

57. The method of claim 56, wherein forming the plurality of cuts is effected from the active surface of the semiconductor wafer body.

58. The method of claim 56, wherein forming the plurality of cuts is effected from the bottom surface of the semiconductor wafer body.

59. A method of singulating a wafer scale assembly, comprising:

securing a semiconductor wafer and another wafer scale substrate superimposed thereon and aligned therewith to form a wafer scale assembly;

cutting at least partially through one of the semiconductor wafer and the another wafer scale substrate; and

cutting at least partially through the other of the semiconductor wafer and the another wafer scale substrate.

60. The method of claim 59, further comprising providing the another wafer scale substrate in the form of a glass substrate, and securing the glass substrate over an active surface of the semiconductor wafer.

61. The method of claim 60, further comprising securing the glass substrate over the active surface of the semiconductor substrate by adhering the glass substrate to a pattern of standoff walls adhered to the active surface of the semiconductor wafer and bounding die locations thereon.

62. The method of claim 61, wherein cutting at least partially through one of the semiconductor wafer and the another wafer scale substrate comprises cutting partially through the semiconductor wafer from a back side thereof in alignment with substantially centers of the standoff walls.

63. The method of claim 62, wherein cutting partially through the semiconductor wafer from the back side thereof comprises etching.

64. The method of claim 62, wherein cutting at least partially through the other of the semiconductor wafer and the another wafer scale substrate comprises cutting through the glass substrate from an exposed side thereof in alignment with substantially the centers of the standoff walls and through the standoff walls and a remaining thickness of the semiconductor wafer.

65. The method of claim 64, wherein cutting through the glass substrate from an exposed side thereof in alignment with substantially the centers of the standoff walls and through the standoff walls and a remaining thickness of the semiconductor wafer is effected by laser ablation.

66. The method of claim 59, wherein the semiconductor wafer includes a plurality of die locations on an active surface thereof, each die location including a plurality of bond pads, and further comprising:

securing another wafer scale substrate including conductive vias extending therethrough between terminal pads located to coincide with bond pads of the semiconductor die to the semiconductor die with conductive bumps extending between at least some of the bond pads and at least some of the terminal pads; and

introducing a dielectric underfill material between the semiconductor wafer and the another wafer scale substrate.

67. The method of claim 66, further comprising providing the another wafer scale substrate in the form of a semiconductor wafer.

68. The method of claim 66, wherein cutting at least partially through one of the semiconductor wafer and the another wafer scale substrate comprises cutting at least partially through the semiconductor wafer from a back side thereof in alignment with boundaries between at least some of the die locations.

69. The method of claim 68, wherein cutting at least partially through the semiconductor wafer from the back side thereof comprises laser ablation.

70. The method of claim 68, wherein cutting at least partially through the other of the semiconductor wafer and the another wafer scale substrate comprises cutting at least partially through the another wafer scale substrate from an exposed side thereof in alignment with cuts

previously made along the boundaries between the at least some of the die locations.

71. The method of claim 70, wherein cutting at least partially through the another wafer scale substrate semiconductor wafer from the exposed side thereof comprises laser ablation.

72. The method of claim 70, further comprising cutting through the dielectric underfill material when cutting through either the semiconductor wafer or the another wafer scale substrate.

73. The method of claim 66, wherein cutting at least partially through one of the semiconductor wafer and the another wafer scale substrate comprises cutting partially through one of the semiconductor wafer and the another wafer scale substrate in alignment with boundaries between at least some of the die locations.

74. The method of claim 73, wherein cutting partially through the semiconductor wafer from the back side thereof comprises etching.

75. The method of claim 74, wherein cutting at least partially through the other of the semiconductor wafer and the another wafer scale substrate comprises cutting partially through the other of the semiconductor wafer and the another wafer scale substrate in alignment with cuts previously made along the boundaries between the at least some of the die locations.

76. The method of claim 75, wherein cutting partially through the other of the semiconductor wafer and the another wafer scale substrate semiconductor wafer comprises etching.

77. The method of claim 76, further comprising cutting through the dielectric underfill material and remaining thicknesses of the semiconductor wafer and the another wafer scale substrate along the boundaries between at least some of the die locations.